

DIVISION OF THE HUMANITIES AND SOCIAL SCIENCES
CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA 91125

A DYNAMIC VIEW OF THE ECONOMY

Burton H. Klein

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Burton H. Klein
California Institute of Technology

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ABSTRACT

This paper argues that U.S. productivity decline occurred because of some profound changes in the American economy. It is also argued that the same changes help to explain the economy's increasing inflationary bias.

INTRODUCTION

No one can deny that the U.S. economy is becoming more predictable than it once was--more predictable in the sense that it no longer generates the technological surprises of the first half of this century. But in the process it has become a more unstable economy: in order to deal with double-digit inflation more serious downturns are required to dampen the rate of inflation.

How can an economy become simultaneously more predictable and less stable? It is commonly believed that a stable economic system must be as predictable as the planets. That stability and predictability go hand in hand, we are told, is no more than common sense. But is it? In the changes made in its product line Chrysler was certainly a far more predictable company after World War II than it was during the 20s and 30s. Yet, at the same time that Chrysler became a more predictable it became a more unstable system. Though in the 30s Chrysler was taking business away from Ford and General Motors, it now is asking the government for a loan needed to compensate for its inflexibility.

Or consider an even larger economic system: by displaying the lowest rate of productivity growth for more than one hundred years the British economy has been the most predictable of all the

industrialized countries. But from the point of view of being able to weather the current economic storm, it is in much the same position as Chrysler.

It is true that in an imaginary unchanging world, economies can be predictable in both the small and the large: that is, they can survive by simply taking the classical law of supply and demand as a given. In other words, microstability (predictability in the small) can be equated with macrostability (predictability in the large) only in a world wherein no surprises occur. But in the uncertain real world, the greater the insistence upon microstability, the more that macrostability will be jeopardized. Thus, while the American steel industry ranks very high from the point of view of microstability--consider how predictable are its technological processes--from the point of view of its overall ability to deal with new circumstances it ranks very low--so low that its predictability in the large is highly dependent upon the adoption by the government of protective measures. An industry that possesses only a modestly greater degree of macrostability is the American automobile industry. Ever since the mid 1920s, competition in the automobile industry featured fewer and fewer substantive changes in its product lines and more and more cosmetic changes. Indeed, as of the early 1960s, competition in this industry relied almost entirely upon "style"--whether in the form of long tail fins or more powerful engines. During the late 60s the industry had to face new challenges in the form of rapidly increasing imports of small foreign cars and rising gasoline prices. However, the slowness of the industry to deal with these challenges only confirms

the fact that once an industry has acquired a high degree of microstability recovery is by no means easy. Though during the earlier postwar years Chrysler survived while being managed by accountants who completely downplayed the technological virtuosity that enabled Chrysler to rise to second place in the industry during the 1930s, reorganizing such a corporation to meet new challenges is something like getting the Army to understand that preoccupation with making tanks ever larger and more powerful by no means constitutes a way to make the outcome of future battles highly predictable.

At the other end of the spectrum are not only relatively new firms such as Hewlett-Packard, but very old firms such as Corning Glass. Both firms are difficult to associate with any particular end product; due to their almost constant efforts to renew themselves their industrial borders have changed very substantially. Thus, ever since it made the glass for Edison's first light bulbs, Corning has been able to generate about one significant innovation every decade. In recent years these innovations included Pyrex glass, ceramic materials to remove the emissions from automobile exhausts, optical fibers (a substitute for copper cables), and a special glass that is used in test kits for diagnosing various diseases. To be sure, not all of its R&D efforts have been successful; for example, trying to develop heat exchangers for turbine automobiles proved to be a blind alley (although work on the ceramics proved to be of critical importance for developing an automobile emissions system).

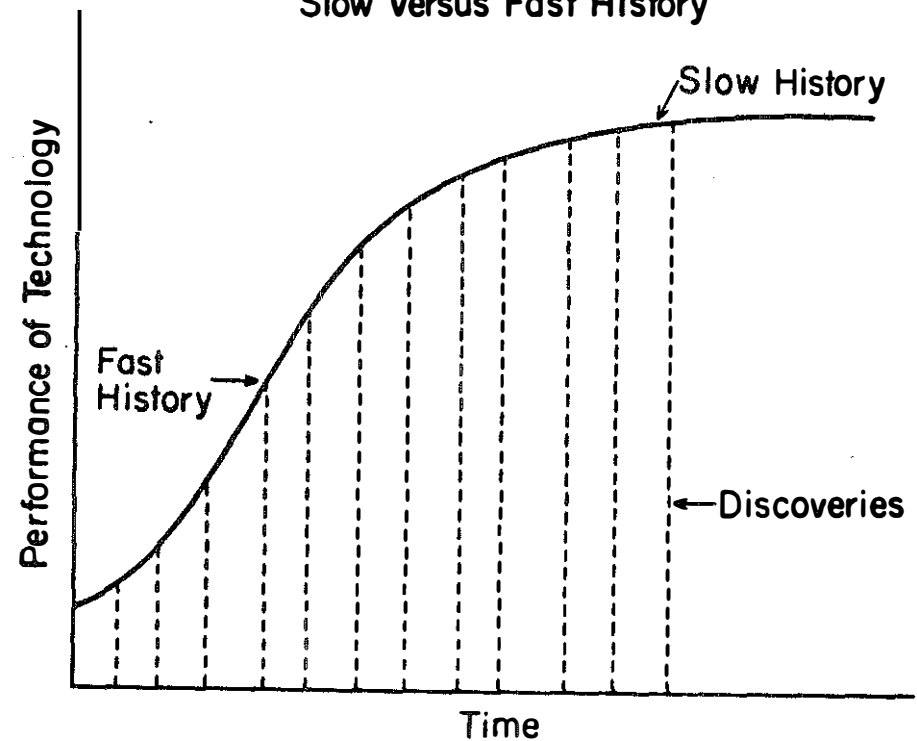
I

What, then, determines whether economies will have a relatively high or low degree of macrostability? To consider this key question, it will be useful to refer to the familiar S-shaped curve relating the performance of a technology to time (Chart I). How is the performance of a technology to be measured? Ideally, we would like to have a single measure that took into account both reductions in costs and improvements in quality. However, since it is practically impossible to devise such a measure, we must choose between a cost or a quality measure, depending upon which will provide the most accurate estimates.

If the performance of a technology is appropriately measured, the typical picture is as shown--in which a period of fast history (with the curve rising rapidly) is followed by one of slow history (when the rate of progress flattens). The dashed lines represent discoveries such as the Model T Ford or the planar transistor--which when viewed as isolated events were quite unpredictable. On the basis of my definition of "dynamic," both fast and slow history are to be regarded as dynamic processes: both involve adapting to new circumstances by discovering new alternatives. The essential difference is that fast history involves dealing with new circumstances more rapidly which requires a higher degree of macrostability.

Why, then, does fast history sooner or later turn into slow history? According to conventional wisdom, after the promising ideas for making nonincremental advances have been exhausted,

CHART I
Slow versus Fast History



entrepreneurs have no alternative but to bring about incremental advances. However, I do not subscribe to this line of reasoning. In the first place, how soon a technology runs into diminishing returns depends on how broadly or narrowly it is defined; and people, not nature, determine how broadly it is defined. For example, if computer technology had been defined to exclude the possibility of semiconductors, today we would be witnessing slow history in computer technology. In the second place, if ideas represented the main shortage, then, when revitalizing discoveries were made--discoveries such as the Bessemer process in steel or the jet engine--we would expect major firms in the industry to account for their share of such discoveries. But of fifty cases I have looked into, in not one did a major firm in the industry bring about a revitalizing discovery. They were made by firms in another industry, new firms in the industry in question, or occasionally by university laboratories, but never by major firms in an industry featuring slow history. Another reason that makes the thesis of diminishing opportunities questionable is that when challenged by newer technologies ways are often discovered to bring about a more rapid rate of incremental improvements in older technologies. Thus, firms in the ice-making business found ways to bring about a whole series of significant improvements when challenged by the newer refrigeration technology. After a serious loss of business to the trucking industry, people in the railroad industry found ways to double their productivity gains. And challenged by synthetic fibers, cotton textiles were improved both in quality and cost.

The principal reason technologies eventually are defined

very narrowly and their progress slows down is not due to a shortage of ideas, but, rather, to a shortage of hidden-foot feedback. Hidden-foot feedback is the feedback a firm receives from its rivals; and it is measured in terms of changes in market shares. Consider, first, a situation in which hidden-foot feedback is maximized: as describes the semiconductor industry of, say, 10 years ago. In this situation firms will be trying to generate highly discontinuous advances; and, if they are doing so, it can be predicted that, statistically speaking, one will almost invariably be favored by luck and cleverness to a greater extent than others. When this occurs the less lucky firms will suffer as much as 30 to 40 percent declines in market shares for an important class of products (and some may go out of business). In such a situation no one in the industry can predict which particular firm will be most favored by luck. However, it can be predicted that in, say, a three year period one or another firm will turn up with a highly successful advance. In such a situation it will obviously pay firms to more or less continuously anticipate negative feedback by being prepared to do to others what they might do to them. And, generally speaking, such situations are to be associated with a high degree of macrostability.

Now at the other extreme, consider industries whose firms have so little ability to cope with uncertainty that they dare not do unto other firms what they would not like other firms to do to them, e.g., the automobile or steel industries. In such industries a delicate balance of power can be maintained only if

the managements impose sharp constraints on their engineers. And it can be predicted that there will be trivial differences with respect to both products and prices. To be sure, even with the hidden foot completely absent, the hidden hand will still result in some productivity gains. But they will be much smaller than when both the hidden hand and hidden foot are in full operation.

In between these extremes there are situations in which, though the size of the advance attempted is not great, there are still quite significant changes in market shares. The strategy will be more or less the same as in the first situation described above, but the premium for imaginativeness will not be as great. Or more commonly, threats may come from newly established firms or from firms in other industries--but they may not be as predictable. For example, during the postwar era AT&T had to deal with a larger variety of threats to its monopolistic position than it had previous to World War II, which in turn motivated it to become a far more dynamic organization. A very quick technological response was the strategy it chose for dealing with such threats. Or, if a technological response did not avail, AT&T effectively responded with intervention in the regulatory process (for example, by preventing underseas telephone cables from becoming obsolete). Thus, the principal difference between AT&T and General Motors is not of a strategic nature but, rather, a difference in the effectiveness of its response. However, if AT&T possessed only Western Electric and not Bell Telephone Laboratories, that difference would not be nearly as significant.

If such firms are to put the odds on their side when dealing with imaginative rivals, they must ask themselves searching questions about their technological opportunities, and tough questions about the need to revamp their organizations to exploit these opportunities (i.e., the entrepreneurial function). Moreover, this question-raising function has a major influence on their internal characteristics. In such organizations there is likely to be a good deal of feedback in the form of pecuniary and nonpecuniary rewards for individual creative accomplishments. Generally speaking, salaries in such organizations are based on creative accomplishments and are not highly correlated with either age or administrative position. In turn, such a reward structure encourages organizations to be highly interactive internally, with their customers, and with universities--so interactive that the authorship of particular discoveries is always in dispute. Consequently, necessity in the form of the hidden foot results in highly interactive questioning organizations, and by doing so, increases the probability that such organizations will be favored by chance.

In short, my explanation of fast history is a statistical one. Necessity, in the form of the hidden foot, stimulates entrepreneurs to ask burning questions, and motivates highly interactive organizations to answer these questions. This activity, in turn, results in a lot of luck, both good and bad. But inasmuch as only the good luck gets recorded, fast history is made to appear so smooth, it seems to have been preordained. Thus, to explain rapid economic progress we need a model which is neither completely deterministic (because it fails to recognize the entrepreneurial

question-raising activity and the associated role of luck) nor completely stochastic (because by failing to recognize that man's destiny is not entirely determined by God's throwing dice is simply another brand of determinism)--but, rather, one that acknowledges a reciprocal relationship between necessity and luck (i.e., a formal dynamic model is now being developed at Caltech).

The principal factor in determining whether or not an industry will generate relatively much or little feedback is the ability of new firms to enter the industry. If they hope to become a major factor in the industry new firms obviously have an incentive to ask themselves tough and searching questions. And by doing so, these newly established firms not only contribute toward producing more than their share of discoveries, they also stimulate existing firms to become quicker borrowers of new ideas.

However, during the evolution of a technology both scale economies and various types of vertical integration become more important--with the consequence that the cost of entering the industry increases by one or two orders of magnitude. This is the essential reason the rate of entry almost always slows down--and the essential reason why fast history is sooner or later superseded by slow history, when due to the relative absence of hidden-foot feedback chance plays a smaller role.

II

Why does a trend toward microstability--as measured in terms of a larger and larger proportion of slow history

industries--jeopardize a country's long-term macrostability, as measured by its rate of productivity gain? If it costs only one twentieth as much to bring about an incremental advance as it does a discontinuous advance, and if twenty small steps bought as much progress as one large one, then slow history would not be expensive history and the rate of productivity gain need not decline. However, generally speaking, incremental advances are likely to be inexpensive only when preceded by a period of fast history; and when not so preceded to cost a good deal more (e.g., as Edsel cost more to develop than the model T; as recently developed jet engines cost much more than earlier ones). True the failure rate associated with discontinuous advances is much greater. But even so, progress via fast history is a good deal cheaper than progress via slow history.

Not only is there much less good luck (as well as much less bad luck), but microstability becomes a way of life. Instead of accepting personal responsibility people impose on themselves all sorts of rules and regulations, so, if anything does go wrong no one can be blamed; and the degree of internal bureaucracy is further enhanced by the formation of tight internal alliances dedicated to the preservation of the status quo. From the point of view of an insider who can have, at best, only a marginal impact on his organization, acting to conserve his power while putting on a great show of looking busy is eminently rational behavior. It is this kind of bureaucratic environment that makes incremental progress so slow and expensive.

Many economists assume that because private firms obey the discipline of the marketplace and public organizations do not, the difference between them is as great as the difference between day

and night. This, however, is simply not true. If bureaucratic behavior is defined as highly predictable behavior that makes organizations highly insensitive to feedback, then we can expect to observe an entire spectrum of private firms from highly adaptive to highly bureaucratic. In industries with little or no rivalry there is no real difference between public and private organizations. For example, in the degree of bureaucratic behavior they display, banks, public utility companies, and steel companies are not very different from the Defense Department, the Post Office Department, or the Environmental Protection Agency.

Although the EPA is not absolutely unique in its degree of bureaucratic (i.e., predictable) behavior, because of its impact on the dynamic stability of the country it does deserve special mention. The EPA has contributed not only to a slowdown in productivity gains, as customarily measured, but also to making progress in lowering the rate of environmental degradation much slower than it otherwise might be. The blame goes back to the Congress which seemed to feel that cleaning up the environment was like a supposedly one-time task of cleaning a dirty room. The authors of the Clean Air Act assumed that by hiring droves of lawyers to oversee this task they could, in effect, repeal the second law of thermodynamics. Unfortunately, however, new things are being learned almost daily about how to increase the rate of productivity as it applies to lessening the rate of environmental degradation. But, because the EPA bureaucracy is almost totally incapable of dealing with new circumstances, progress is both

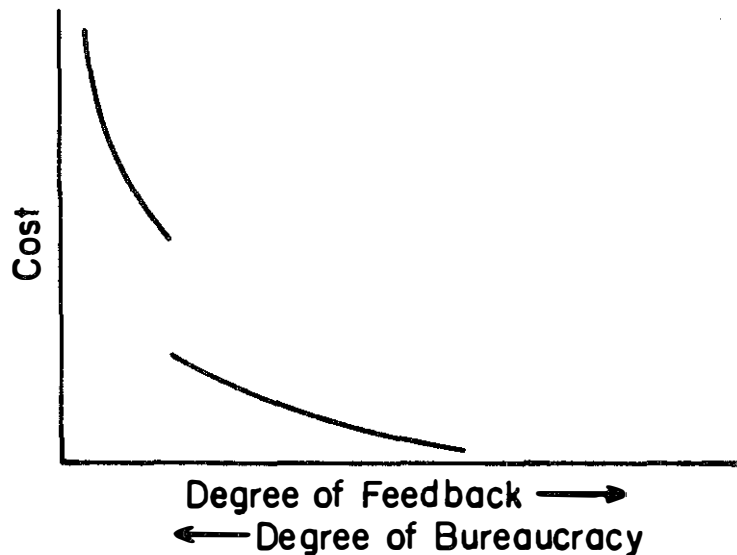
terribly slow and terribly expensive. Nevertheless, it is my conviction that the fundamental factor for the productivity decline has been the increasing shortage of hidden-foot feedback.

To summarize: There is a longer-term tradeoff between the degree of hidden-foot feedback and the cost of making progress. This is the discontinuous tradeoff shown in Chart II. When the entry of new firms creates a good deal of hidden-foot feedback, the cost of progress will be relatively small. On the other hand, when because of a shortage of such feedback organizations impose a high degree of bureaucracy upon themselves, the cost of progress is likely to be very large. It should be apparent, therefore, that a decline in feedback and an increase in private and public bureaucratic behavior threatens the longer-term stability of the economy by making the role of productivity gain smaller than it otherwise would be. And the essential reason that the long-term rate of productivity gain in the U.S. is falling is that we are being driven up to the top of this discontinuous curve.

III

A serious decline in feedback jeopardizes not only the long-term but also the short-term economic stability of an economy. In particular, the decline begets an economy in which larger and larger recessions are required to restrain the rate of inflation. Putting aside the inflation issue for a moment, I want to point out, first, that an economy in which a significant number of industries are generating a large amount of feedback minimizes the amplitude of business cycles, because those industries that generate a good

CHART II
Degree of Feedback versus Cost of Progress

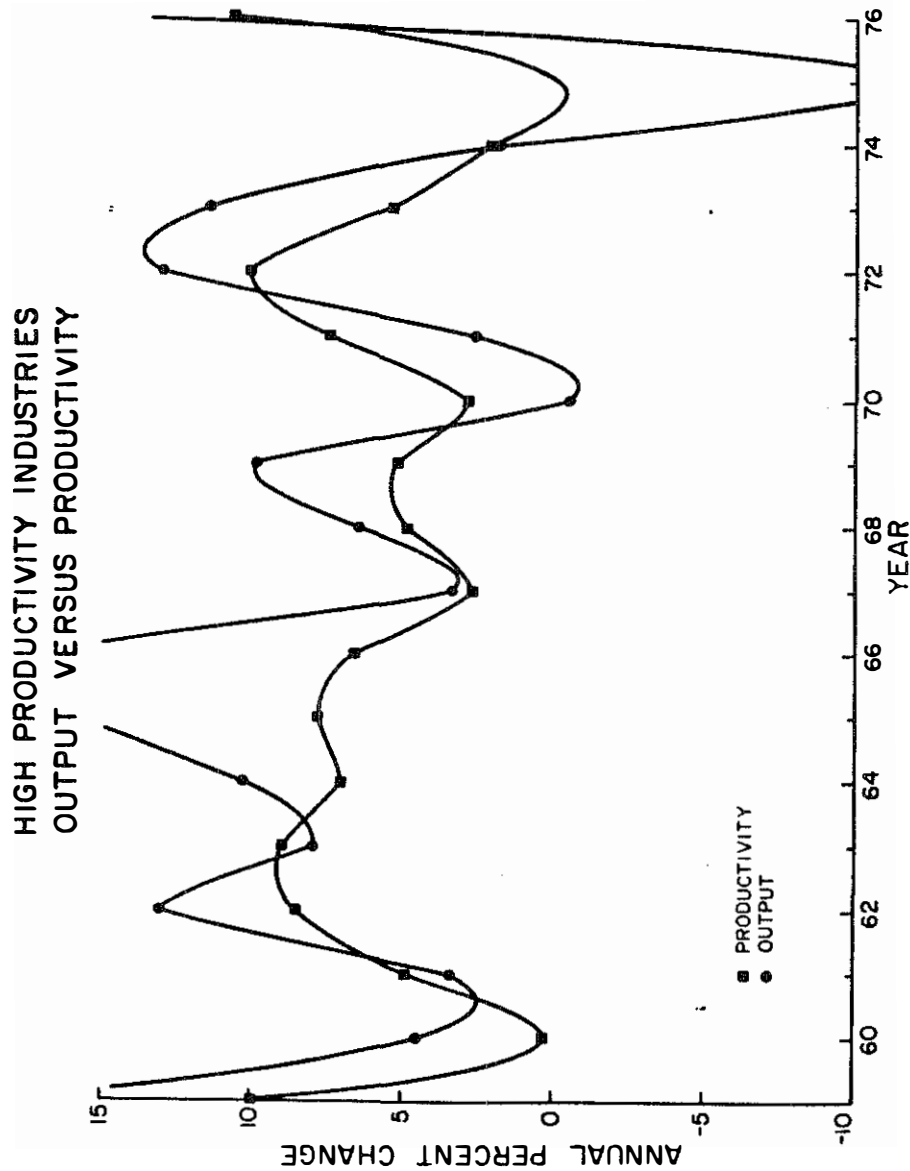


deal of feedback are likely to suffer less from economic downturns.

To test this and another hypothesis, over the summer I was engaged in research concerning the statistical performance of some 500 manufacturing industries. The study, covering the period 1958 to 1976, was based upon unpublished data for these industries supplied by the Bureau of Labor Statistics. The data base included information on output, productivity, prices, unit labor costs and wage rates.

To analyze the data we divided industries into three groups based upon their performance in bringing about productivity gains during the first half of that period. The high performance group was defined as those industries whose mean rate of productivity gain during the first half of the period was more than one standard deviation above the average, and included industries such as semiconductors, computers, synthetic fibers, pharmaceutical preparations, fertilizers, radio and TV sets, household refrigerators, and malt beverages: industries seemingly characterized by a relatively high degree of rivalry (although direct measures of changes in market shares are unavailable). The low performance group was comprised of industries whose productivity gains were one deviation below the average, and it included industries such as frozen fruits, men's and boy's suits, newspapers, books, metal cans, and primary lead: industries characterized by very little rivalry.

As Chart III shows, until the 1973-1974 downturn, recessions in the high performance group of industries were almost entirely

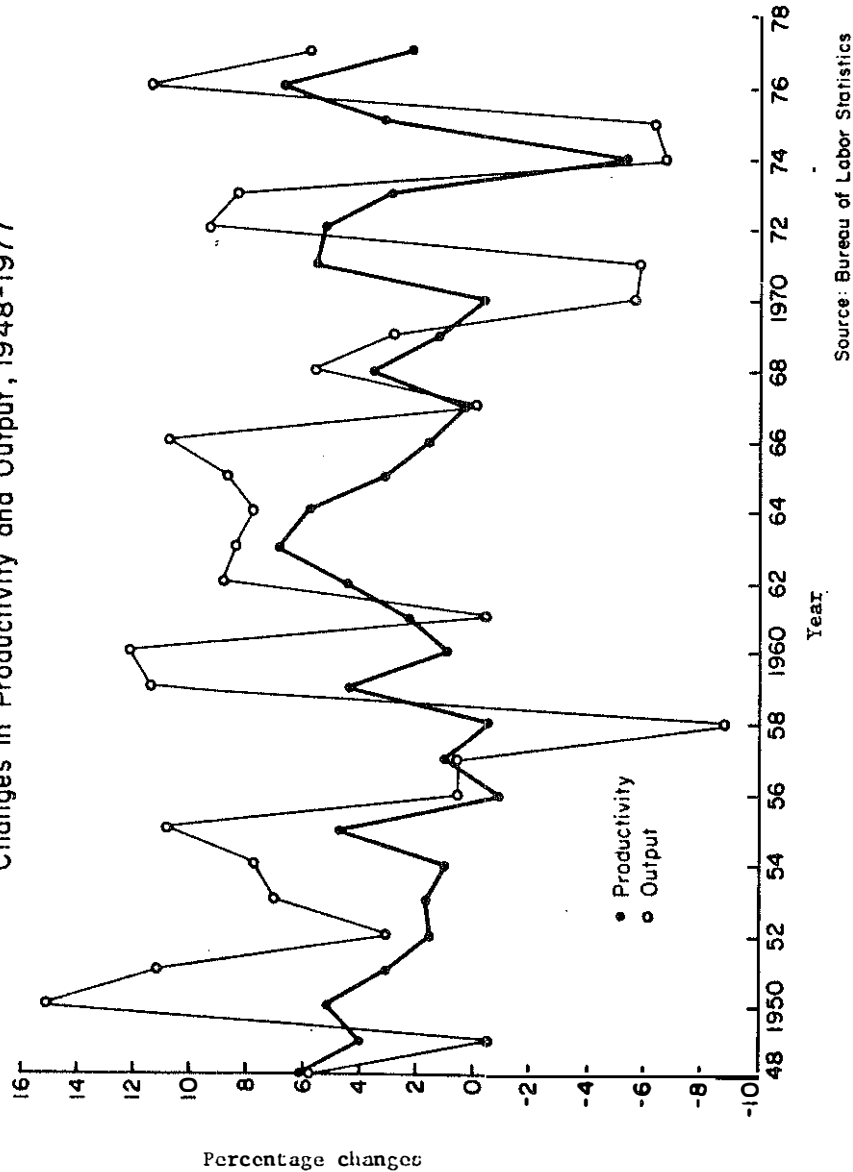


in their rate of growth. There are two reasons why, by being less subject to downturns, such industries contributed to the overall stability of the economy. First, firms that have to deal with a large amount of feedback more or less continuously and experience sharp downturns even when the economy is highly prosperous are better able to deal with recessions. Second, by virtue of having an advantage over less dynamic firms in being able to recognize a potential unsatisfied demand for new products, such firms tend to be involved in activities that are less subject to downturns. For both of these reasons the regions of the country less affected by serious downturns are those that have industries characterized by a relatively high degree of macrostability, for example, California or the southern states since World War II.

However, as Chart III shows, during the 1973-1974 downturn the high performance industries experienced a very significant decline in output, in fact, a decline quite as serious as in the medium and low productivity industries. And their productivity performance began to display a more cyclical pattern. Indeed, by being highly associated with the business cycle their productivity performance began to resemble that of the medium and low performance groups.

As Chart IV shows, in manufacturing industries as a whole the rate of productivity increase tends to slow down during economic recoveries in anticipation of a general decline in output; and in increases during recessions in anticipation of an upturn in the level of output. Thus, the 1958, 1970, and the

CHART IV
Changes in Productivity and Output, 1948-1977



1973 downturns were preceded by periods in which the trend of productivity gain was generally downward. Moreover it should be noted that this pattern of behavior is not peculiar to the post-World War II period. Since 1890, movements in productivity in manufacturing as a whole have been highly associated with the business cycle--and in three out of four cycles movements in productivity have provided good lead indicators of both downturns and upturns.

How is this to be explained? It is true that capacity constraints become more and more important during an upturn, and that to further expand the labor force it is necessary to draw upon marginal workers. It is also true that once the downturn starts there is a tendency not to reduce employment as rapidly as output declines. However, such an argument cannot explain why the rate of productivity increase (as distinct from the absolute level of productivity) rises above zero during upturns, providing the economy with a higher absolute level of productivity than it ever had before. As Chart IV shows, only in the 1973-1974 downturn did the rate of productivity gain go below zero. In general the most impressive advances in the rate occur while coming out of recessions.

My explanation of such behavior is simply this: In industries in which the hidden foot plays a relatively modest role, negative feedback in the form of lower profits occurs mainly during recessions. Therefore, it can be predicted that their search for ways to improve productivity will be widest when

negative feedback is maximized and narrowest when minimized.

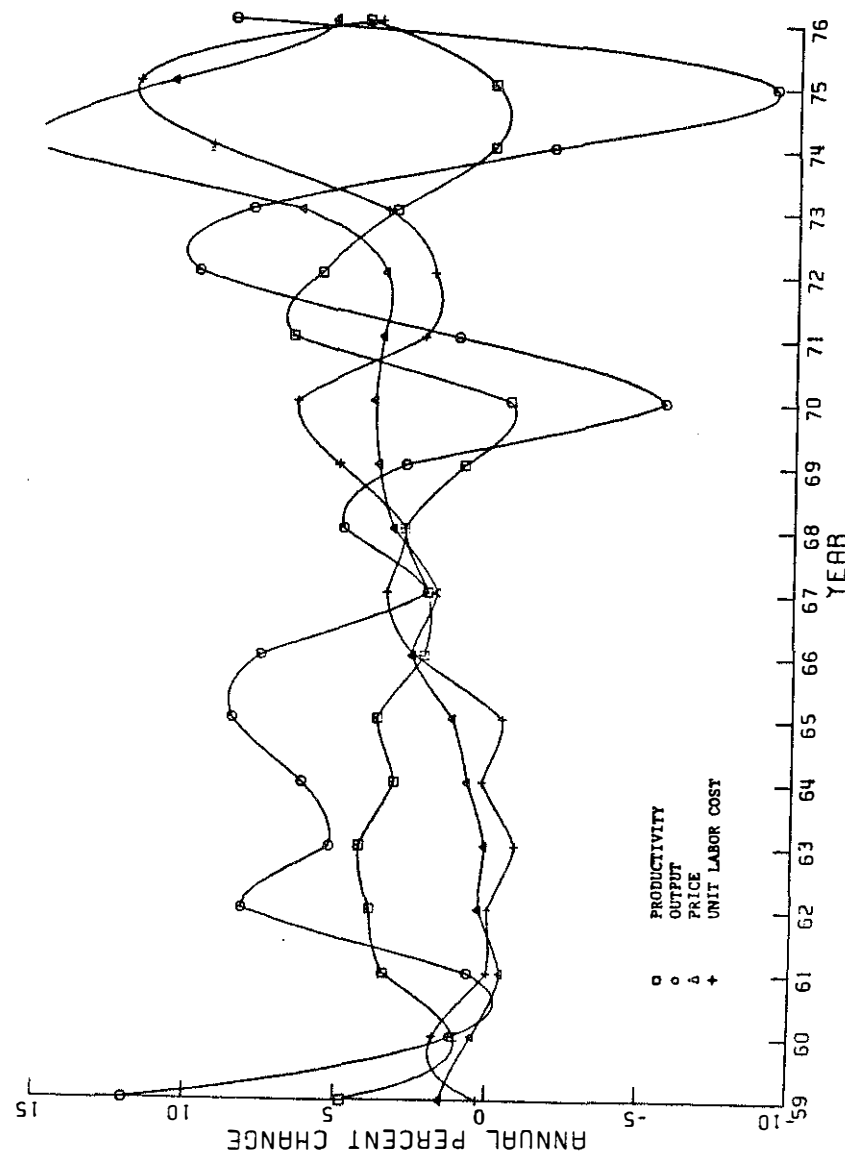
Thus, even putting the question of inflation aside, it should be apparent that a decline in feedback will jeopardize the short-run stability of the economy. The less firms depend upon each other for their negative feedback, and the more they depend on economic downturns, the greater will be the downturns.

IV.

Finally, I will describe how an economic system obsessed by the desire for microstability tends to generate a maximum rate of inflation while the country is heading into a recession—which greatly complicates the task of controlling inflation. This tendency was exhibited most strikingly during the downswing which began in 1973 and ended in 1975, at which time the rate of inflation in manufacturing increased from about 3 percent to over 11 percent annually (Chart V). True, something like one-third of the overall rise in prices can be attributed to the increased cost of oil inputs. But, after taking OPEC actions into account, we are still left with the conclusion that in manufacturing the rate of inflation more than doubled during the downturn, and abated only after recovery was well underway. Moreover, it should be noted that this sort of price behavior is not new. During the recession which began during the late 1960s the rate of inflation in manufacturing doubled. In fact, during each major downturn since World War II prices have behaved less flexibly than in the preceding one.

How is this price behavior to be explained? In the first

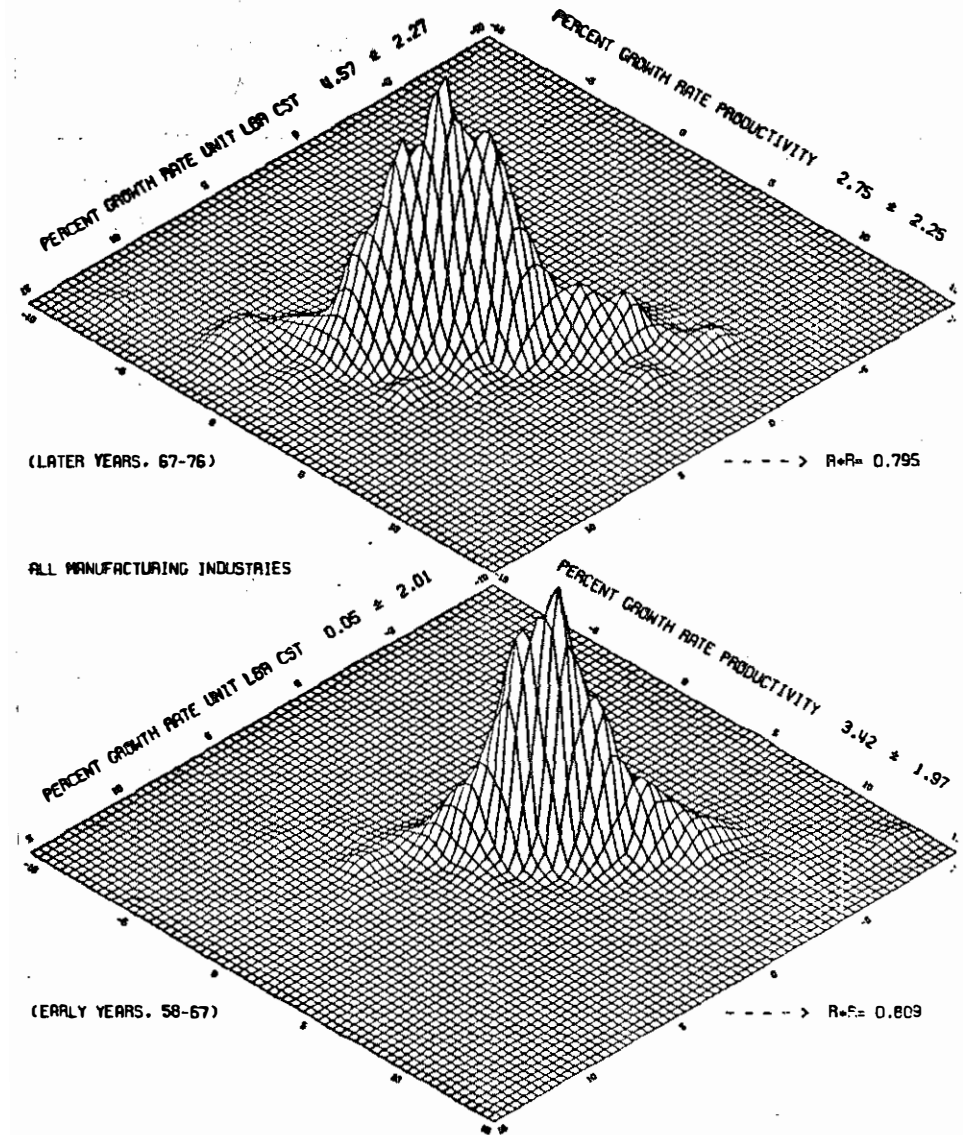
CHART V
PERFORMANCE OF MANUFACTURING INDUSTRIES AS A WHOLE



place, as was already pointed out, there is a tendency for the rate of productivity advance to begin declining before output has reached its peak, and to continue to decline during the downturn.

Closely associated with this tendency is the fact that unit labor costs increase during downturns (curve labelled +). Unit labor costs are defined as the average costs of producing a particular volume of output; and in manufacturing they account for roughly 75 percent of all costs. Now, unit labor costs reflect changes in wage rates as well as in productivity. If productivity rises more rapidly than wage rates unit labor costs will decline; if hourly wage rates rise more rapidly than productivity they will increase. Nevertheless, the cyclical swings in productivity have been so large that their influence upon unit wage costs has been the dominant influence. This is indicated by Chart VI, which shows the relationship between changes in productivity and changes in unit wage costs. For those not familiar with this type of diagram, note that it is constructed simply by counting the number of observations in each cell and by making the heights of the contours proportional to them. Its main advantage over the familiar scatter diagram is that it better permits us to see the changes which have occurred in a distribution between two time periods. In this particular case, the global correlation coefficient, R^2 , remained about the same in both periods; and the principal change was an extension of observations along the correlation line--that is, relatively high negative productivity rates became

CHART VI
PRODUCTIVITY VS UNIT LABOR COST

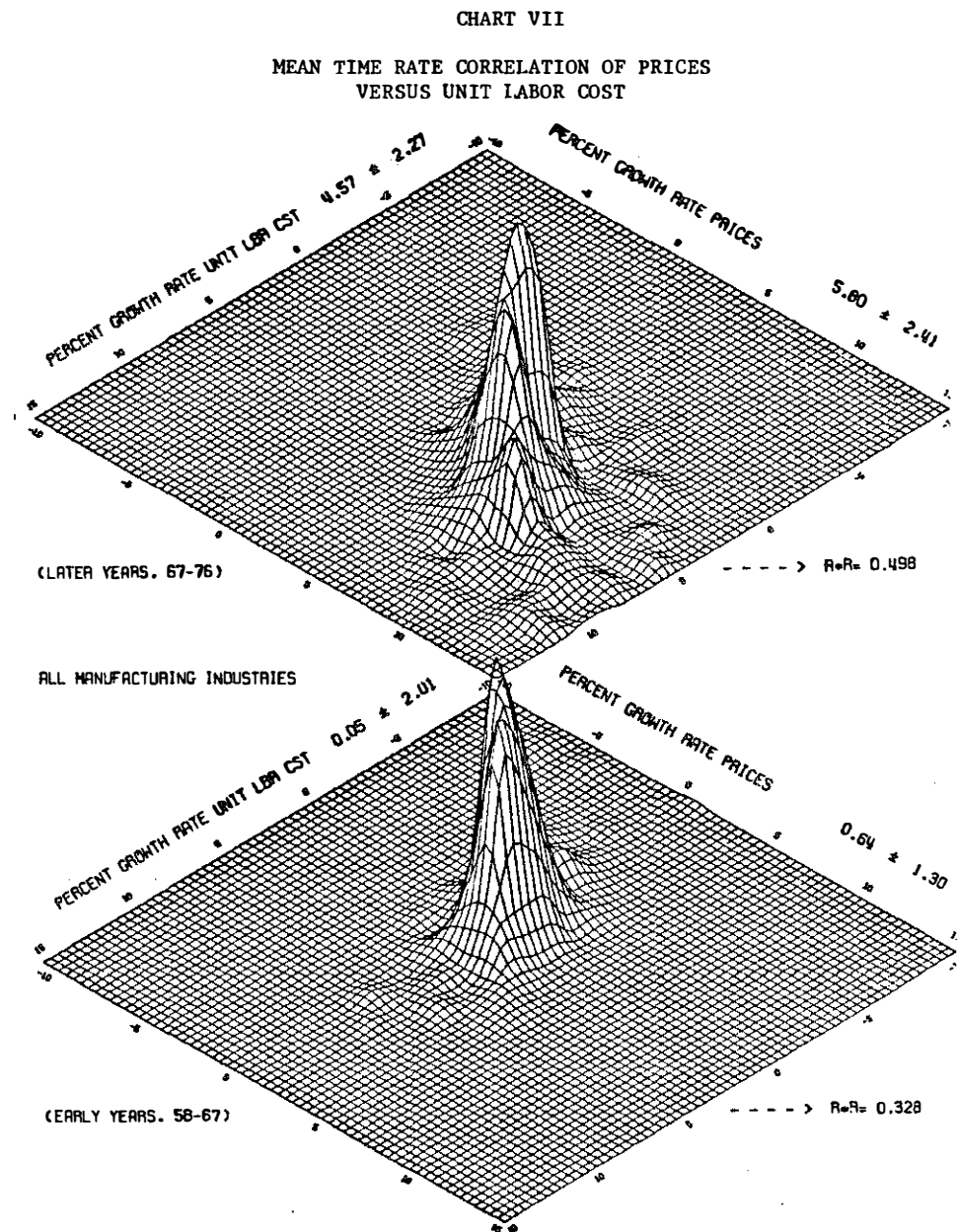


associated with very large increases in unit wage costs; and very large productivity rates became associated with small increases in unit costs.

In short, the picture is almost the direct antitheses of the conventional wisdom in economics. According to most macro models, steady advances in productivity occur routinely--and increase in wages during periods of high employment lead to higher prices. However, as was explained previously, during the last two downturns, the maximum rate of inflation occurred not when unemployment was low but, rather, when relatively high. And because cost-of-living allowances have played an increasingly important role in wage contracts, wage rates too have become relatively insensitive to the rate of unemployment. Thus, during the past two recessions there was no significant reduction in the rate of increase.

At the same time as movements in prices have become less and less sensitive to general business conditions, they have become increasingly sensitive to costs. As Chart VII shows, from the period 1958-1967 to the period 1956-1976, the coefficient of correlation (R^2) between unit wage costs and prices moved up from .3 to .5, with very large increases in unit costs tending to be associated with large increases in prices. Moreover, after adjusting for increases in the cost of oil inputs, the coefficient of correlation during the latter period is almost .65.

We all know that if business firms are to survive in the longer-run prices must cover costs. But apparently business firms would like, if they could, to set prices in a manner to



balance their budgets at each point during the business cycle. Just as R & D projects are managed in a way to insure a high degree of predictability in the short-run, so are prices. And both reveal an economy possessed with a quest for microstability.

The increasing insensitivity of wages and prices to economic downturns is, of course, but another indication of the development of highly bureaucratic business firms and labor unions. In industries featuring a good deal of rivalry there are typically large differences in profit rates; and for fear of putting less profitable firms out of business union leaders in such industries have been very statesmanlike in their wage demands. Consequently, during the period 1958 to 1967, wages in the high productivity industries increased by no more than wages in the medium and low productivity industries. And when wage and price escalation started in the late 1960s, it was industries like steel that led the way. It can be agreed, of course, that were it not for the large increase in public expenditures during the late 1960s inflation might not have started. But it also must be agreed that an economy in which highly bureaucratic business firms and labor unions thrive because of a shortage of hidden-foot feedback is an economy highly vulnerable to inflationary shocks.

Moreover, once inflation has begun, such wage price behavior leads to deeper recessions, because more stern action must be taken in order to throttle the rate of inflation. Indeed, if it is needed to prevent a really serious economic disaster, a recession with an 8 to 10 percent unemployment rate no longer seems as serious as it once did.

V.

In summary, if my argument is correct, the inability of a dynamically unstable economy to deal with new circumstances can be revealed in several ways, including in the short-run a relatively low ability to deal with inflationary shocks and recessions, and in the longer-run sharp increases in the cost of progress and a consequent reduction in the long-term rate of productivity gain.

Given the self-correcting role that feedback plays in other systems, it would be surprising, indeed, if it played an almost zero role in the functioning of an economic system. To be sure, in an economic system negative feedback does not result in the almost automatic self-correcting mechanism it does in a cybernetic system such as steering a ship. Rather, its role is more like that played by feedback in biology--for example, when confronted by necessity chimpanzees can be observed to invent completely new tools for themselves. But the fact that feedback does not play an automatic role in economic and biological systems does not make its role any less important.

It is my conviction that until this role is better understood and more widely appreciated, there is little hope for policy reform in this country. Indeed, unless the stabilizing role becomes regarded as a very natural role, and unless politicians become something other than experts at removing feedback from an economic system, capitalism will not survive.